(12) UK Patent Application (19) GB (11) 2 036 115 A

(21) Application No 7938262
(22) Date of filing 5 Nov 1979
(30) Priority data
(31) 53/140709
(32) 15 Nov 1978
(33) Japan (JP)
(43) Application published 25 Jun 1980
(51) INT CL³ D04H 1/54
(52) Domestic classification D1R 3B4 3C2B 3C2C 3C2G 3C2P 3C2X 3C2Y 3C5A 3C5D 3D1B 3D3F 3D3X 3D4B A4K AX
(56) Documents cited GB 970817 GB 829908
(58) Field of search A4K B5A D1F D1R

(71) Applicant
Chisso Corporation, 6—32, Nakanoshima 3-chome, Kitaku, Osaka, Japan
(72) Inventors
Taizo Sugihara,
Hiromu Sonoda
(74) Agent
Marks & Clerk

# (54) Process for Producing Rod-Shaped Fibre Articles

(57) In a process for producing rod-shaped articles from fibres, such as tobacco filters and writing elements for sign pens, a fibre bundle containing 20% by weight or more of hot-melt-adhesive composite fibres is continuously introduced into a shaping apparatus provided with an injection chamber 6, a fibre bundle-introduction pipe 1 and an exit 4, for the fibre bundle; directly and indirectly heated and hot-melt-adhered by a hot compressed gas injected into the apparatus; and shaped at the exit, followed by taking-out and cooling, and cutting if necessary. The hot-melt-adhesion can be carried out rapidly and uniformly and the resulting rod-form fibre shaped articles show uniform adhesion both outside and inside thereof and a good dimensional stability.

FIG. I

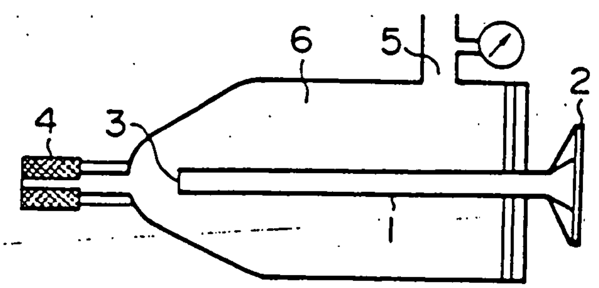


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FIG. 1

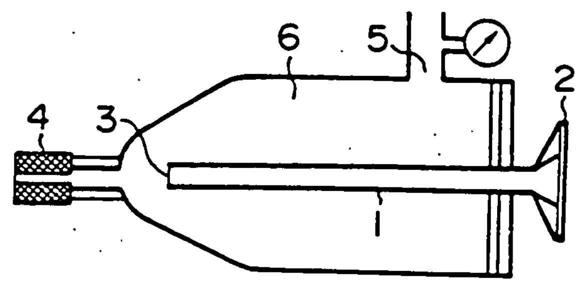
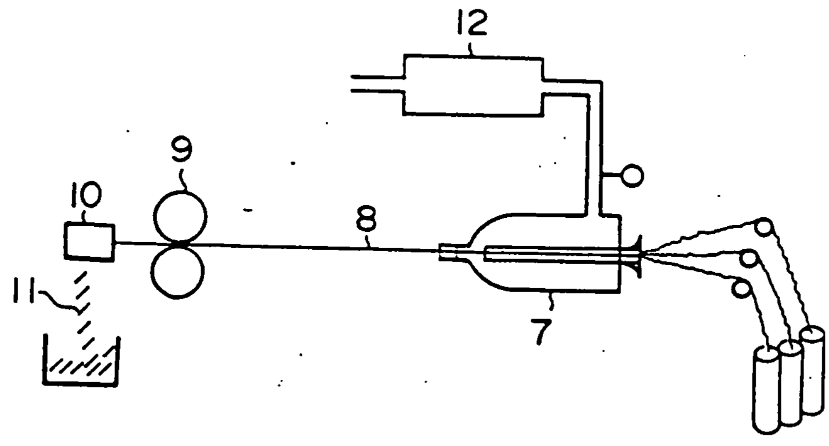



FIG. 2



SPECIFICATION

## Process for Producing Rod-Shaped Fibre Articles

The present invention relates to a process for producing rod shaped articles of fibre. More particularly it relates to such a process which involves heating and shaping a fibre bundle containing at least 20% by weight of hot-melt-adhesive composite fibres, while employing a specified shaping apparatus.

Rod shaped fibre articles are employed for example in filters and as a core for sign-writers' pens, more generally known in the United Kindgom as "felt-tipped" pens. For sign pens, as the products are usually called in Japan, and for felt-tipped pens, the portion corresponding to the tip end of a conventional pen is made from compact fibrous material. The rod-form articles are conventionally prepared by cutting filled felts of wool or felts of chemical fibres or synthetic fibres obtained by employing a binder or drawing through a mechanical entanglement, to a definite shape and size.

Furthermore, in such a case as in making tobacco filters, a process has been used which involves adhering triacetin onto a crimped tow to plasticize it, followed by shaping into a rod. Still further, in recent years, various fibre shaped articles have been produced employing hot-melt-adhesive composite fibres, eg by passing a fibre bundle through a tube heated from the outside. However there has been a drawback in the latter process that the difference in the heating extent between the surface of the fibre bundle and the inside thereof is liable to increase, and the deformation of the resulting shaped articles is also liable to occur.

The object of the present invention is to provide a process for producing rod-form shaped articles from fibre bundles comprising hot-melt-adhesive composite fibres, which articles are sufficiently hot-melt-adhered even as far as the inside thereof and have no deformation, the articles being produced within a very short time and easily.

The present inventors have found that if hot-melt-adhesive composite fibres are contacted fully and directly with a hot compressed gas heated up to a hot-melt-adhesive temperature, it is possible to cause the fibres to attain a hot-melt-adhesive state instantaneously, and making skilful use of this finding, have conceived the present invention.

The present invention resides in a process for producing rod shaped articles by heating a fibre bundle containing at least 20% by weight of hot-melt-adhesive composite fibres, followed by cooling. In the present process there is the improvement which comprises employing a shaping apparatus. The apparatus has an injection chamber provided with an injection opening opening on the wall thereof, and exit for said fibre bundle, the exit having a die of a desired cross-sectional shape, and a pipe for introduction of said fibre bundle. The pipe has a bore of larger cross-sectional area than that of said die, and is located opposite to said exit and protruding into the inside of said chamber and toward said exit.

In performing the process, the fibre bundle is passed through said pipe to said exit, while a hot compressed gas is injected through said injection opening into said injection chamber, thereby to heat and shape said fibre bundle at its hot-melt-adhesive temperature.

The present invention will now be considered in more detail. The hot-melt-adhesive composite fibres employed in the present process are most suitably any of those wherein the difference between the melting points of the composite components of the composite fibres is in the range of 10°C to 100°C, and wherein the low melting component forms at least a part of the fibre surface and has a hot-melt-adhesive property. For preference, the difference between melting points is 20°C to 60°C, and the fibres have a side-by-side or sheath-and-core structure, with a circumferential proportion of 50 to 100% of the low melting component in the fibre cross-section.

For the combination of the composite components, (polypropylene/polyethylene), (polypropylene/ethylene-vinyl acetate copolymer or its saponified product or a mixture of them with polyethylene), (polyester/polypropylene), (nylon6/nylon 66) and the like combinations can be used. When the composite fibres are heated at a temperature between the melting points of the two composite components, ie. at a hot-melt-adhesive temperature. The low melting component melt-adheres while the fibre shape is maintained.

The fineness of the fibres is typically selected to lie in a broad range of 0.5 D/F to 200 D/F (D/D: abbreviation of "denier per filament"). Either crimped or uncrimped composite fibres may be employed, but the former (eg in the range of 3 to 30 crimps/inch) is preferable. Either mechanical or steric crimps may be employed.

As for the shape of the fibre bundle, tow, filaments, sliver, spun yarns, etc may be employed. As for the other fibres to be mixed with the composite fibres, natural fibres, bast fibres, chemical fibres, synthetic fibres, etc may be employed.

For the hot compressed gas, air or steam is usually employed, but other gases such as nitrogen gas may be employed. Steam is superior to air in heat conduction, and can make the apparatus employed more compact, and also can make the shaping speed higher, but, in case where moisture is undesirable, air is preferable. In order to transfer heat to the fibre bundle as fast as possible, the heated gas is pressurized by compression in advance; then passed through even as far as the inside of the fibre bundle, in the form of gas stream intensified by injection; and discharged into the atmosphere after pressure reduction. Thus, a line pressure of the compressed gas to be injected of 1—5 Kg/cm² (gauge)

(hereafter abbreviated to G) is preferred. The temperature before injection is preferably in the range of 110°C to 200°C. For heating the gas, it may be passed through a heater heated by a sheathed heater, or piping through which the gas is passed may be heated from the outside.

A production process of the present invention will be described by way of non-limiting example with reference to the accompanying drawings in which:

Fig. 1 shows a shaping apparatus preferably employed in the production process of the present invention; and

Fig. 2 shows a flow sheet illustrating an embodiment of the production process of the present invention.

In the Figure 1, the shaping apparatus has a fibre bundle-introducing pipe 1 with tip 3; a funnel-shape guide 2 fixed to the pipe 1; a die 4; an injection opening 5; and an injection chamber 6. From the shaping apparatus 7 a fibre bundle 8 is shown in the Figure 2 passing to a takeup means 9 and a cutter 10 to give product 11. A heater 12 supplies hot compressed gas.

In operation, a fibre bundle is drawn through the funnel-shape guide 2 into the introduction pipe 2, leaves the pipe at the tip end 3 thereof, and is further drawn through the die 4 to the outside of the shaping apparatus. When hot compressed gas from heater 12 is injected through the injection opening 5 into the injection chamber 6, the injected hot gas heats the introduction pipe 1 from the outside thereof, and advances toward the die 4 as well as toward the funnel-shape guide 2 through the introduction pipe 1, so as to exit to the outside atmosphere. The cross-sectional area of the hole of the introduction pipe 3 is larger than that of the die 4, and thus the fibre density of the fibre bundle in the cross-section of the introduction pipe is less than that in the cross-section of the die.

Thus the clearances between fibres in the cross-section of the introduction pipe are larger than those of the die; hence even if the length of the introduction pipe is large, most of the injected hot gas passes through the introduction pipe and goes out to the outside atmosphere, whereas the amount of the gas passing through the die is small. Accordingly, the fibre bundle, while passing through the pipe, is heated not only from the outside of the pipe, but also by the hot gas passing through the inside of the pipe; hence the fibre bundle is uniformly heated even as far as the inside thereof, and yet heated into a hot-melt-adhesive state in a very short time, such as 0.1 to 2 seconds. Usually it is found that if only the outer surface of the introducing pipe is heated, the inside of the fibre bundle is insufficiently heated, while if the hot gas is passed only through the inside of the pipe, the outside of the fibre bundle is also insufficiently heated, since the gas passing through the portion of the fibre bundle close to the outer peripheral surface of the fibre bundle is more cooled by the outside atmosphere and also more reduced in flow velocity than the gas passing through the central portion of the fibre bundle.

The fibre bundle receives additional heat between the tip end 3 of the introduction pipe 2 and the die 4 to facilitate and ensure the shaping of the fibre bundle into various cross-sectional shapes, exerted by the die.

By locating the injection opening near to the base part of the introduction pipe, it is possible sufficiently to heat the outer surface of the introduction pipe, and also to prevent overheating and disturbance of the fibre bundle caused when the gas is injected directly toward the fibre bundle going out of the tip end of the introduction pipe.

In the present process, the fibre bundle is heated uniformly even as far as the inside thereof, in the state of a relatively low density, as the fibre bundle passes through the introduction pipe; hence, in the case where the fibre bundle has heat-deformable properties, the development of latent crimps and shinkage occur uniformly. Thus, the shape formed by the die is stabilized and no deformation thereafter occurs.

If the cross-sectional area of the hole of the introduction pipe is too large, the release of the gas from the inlet through which the fibre bundle is introduced is so rapid that heating of the fibre bundle becomes rather difficult. If the area is too small, the fibre bundle is press-bonded or brought into a non-uniform adhesion state, and in an extreme case, the bundle cannot be drawn out of the die. As for the cross-sectional area of the bore of the introducing pipe, those in the range of 1.2 to 4 times the cross-sectional area of the aperture of the die are preferable.

As for the length of the introduction pipe, in order to heat the outer peripheral portion of the fibre bundle directly by the hot gas for a while, and also in order to provide the inlet through which the hot gas inside the injection chamber is introduced, the length of the introduction pipe is preferred to be selected so as to allow a space, between the tip end of the introduction pipe and the die, corresponding to one-tenth to three-tenths of the total length of the injection chamber including the introduction pipe inside the injection chamber and the die.

As for the cross-sectional shape of the die for shaping, those corresponding to a desired cross-sectional shape of shaped articles, such as circle, ellipse, wavy circle and zigzag circle, are employed. As for the material for the die, conventional stainless steel may be sufficient, but if the fibre bundle is particularly liable to melt-adhere onto metals, a material such as Teflon (Registered Trade Mark) may be employed.

The resulting shaped rod leaving the die is cooled and solidified and taken up by a take-up means 9 and then cut to a desired length by a cutter 10. The cooling may be carried out in a conventional manner such as passing through a pipe cooled by air or water. In the case of air-cooling, this is usually carried out between the end of the die and the drawing means. As for the

drawing, an extent of light nipping with rolls may be sufficient.

As for the effectiveness of the described process of the present invention, the following points are mentioned:

(1) Rod-form fibre shaped articles can be obtained in which the fibres are sufficiently and uniformly adhered together not only outside but also inside the articles. The products typically exhibit a superior dimensional stability.

(2) It is possible to produce the articles very easily, at a high speed and by means of a compact apparatus.

(3) It is possible to obtain rod-form fibre shaped articles which are uniformly hot-melt-adhered even as far as the inside thereof; hence it is possible to afford a fibre bulk density in a considerably broad range such as a range of 1% to 40%.

## Example 1

Filaments of hot-melt-adhesive composite fibres (side-by-side structure) consisting of polyethylene (mp 135°C) as a low melting component and polypropylene (mp 165°C) as a high melting component and having a circumferential proportion of 60% of said low melting component in the fibre cross-section were collected and stretched to 3 times the original length at room temperature, followed by relaxation to generate crimps. The resulting crimped fibre bundle having a fineness of 3 D/F and a total fineness of 300,000 deniers was shaped into a rod form. The rod bundle was injected into a shaping apparatus as shown in Fig. 1, provided with a fibre bundle-introduction pipe having a length of 20 cm (which refers to the portion inside the injection chamber, the total length of the injection chamber being 24 cm), and a circular die of 15mm$\phi$. Steam heated to 140°C and having a pressure of 5 Kg/cm$^2$(G) was supplied by heater 12. The fibre bundle was passed through the shaping apparatus at a rate of 30 m/min to shape it on heating, followed by cooling and drawing and then cutting to 10 cm to produce a central core for oil-based sign-writer pens.

Since such a core consists of a crimped fibre bundle which is a uniformly, finely and partially adhered state, fine clearances are uniformly composed, and a good ink-retainability is obtained, whereby twice the conventional amount of ink can be retained. Furthermore since the core is produced from the continuous filaments, ink discharge is smooth. Thus the product is most suitable as a core for a sign-writer pen.

## Example 2

Thirty percent by weight of highly crimpable heat-adhesive composite fibres (side-by-side structure, 3 D/F, 102 mm) consisting of a 1:3 blend (mp 110°C) of ethylene vinyl acetate copolymer (which will be abbreviated to EVA) (vinyl acetate content: 20%) as a low melting component and polypropylene (mp 165°C) as a high melting component, and having the low melting component as the circumferential proportion in the fibre cross-section were blended with 70% by weight of highly crimpable cellulose acetate staple fibres (4 D/F, 102 mm) by means of a card, and the resulting blend was opened to obtain a sliver of 9 g/m.

This sliver was passed through a shaping apparatus as shown in Fig. 1, provided with a fibre bundle-introduction pipe having a length of 30 cm (the total length of the injecting chamber being 42 cm), while compressed air heated to 120°C and having a pressure of 3 Kg/cm$^2$(G) was injected into the chamber. The fibres were drawn out of a circular die of 8 mm$\phi$ and cut to 102 mm, to obtain a plug for tobacco filter. This product was superior in the fragrant smoking taste, the retainability of nicotine and tar, and resilience; hence it was fully useful as a tobacco filter plug.

## Example 3

A crimped tow (total denier: one million deniers) of heat-adhesive composite fibres (sheath-and-core type, 30 D/F) consisting of polypropylene (mp 165°C) as a low melting component and a polyester supplied from Toyobo Company, Japan (mp 190°C), as a high melting component, was opened, and then passed through a shaping apparatus as shown in Fig. 1, provided with a fibre bundle-introduction pipe having a length of 50 cm (the total length of the injecting chamber being 65 cm), while steam heated to 170°C and having a pressure of 5 Kg/cm$^2$(G) was injected into the apparatus. The bundle was drawn out of a star-form die (length of one side: 1.5 cm), to obtain a fibre pile having a length of 15 m, useful as a draining material for wet ground.

This product had a high tenacity due to its composition of a fibre bundle consisting of the continuous filaments; a high water-permeability due to its point adhesion (water-permeability coefficient: $3.7 \times 10^{-2}$cm/sec); and a large water-collecting effectiveness as well as lightness due to its star-form pile. Thus it was most suitable as a raining material.

## Example 4

A fibre bundle of 70,000 deniers was prepared by collecting crimped filaments of hot-melt-adhesive composite fibres (side-by-side structure, 6 D/F) consisting of EVA (vinyl acetate content: 5%, mp 105°C) as a low melting component and polypropylene (mp 165°C) as a high melting component, and having a circumferential proportion of 70% of the low melting component in the fibre cross-section. The fibre bundle was passed through a shaping apparatus as shown in Fig. 1, provided with a fibre bundle-introduction pipe having a length of 20 cm (the total length of the injection chamber being 23 cm), while air heated to 130°C and having a pressure of 2 Kg/cm$^2$(G) was injected into the chamber. The fibre bundle was then press-adhered and finished by means of a square die of 4 mm×4 mm at the

exit portion so as to give a somewhat hard product, followed by cooling and cutting. The resulting material was sharpened into a bell-form or so as to form an acute angle to obtain a tip core for "Fude" (a Japanese term; a writing brush) or "felt-tipped" pen.

This product is superior in discharge of liquids such as ink due to its composition of long fibres, and hard but elastic since adhesion by means of resins is not employed Thus it is suitable as a tip core for "Fude" for writing for cosmetic use.

## Claims

1. A process for producing rod-shaped articles by heating and then cooling a fibre bundle containing at least 20% by weight of hot-melt-adhesive composite fibres, in which process the fibre bundle is introduced into a shaping apparatus through a pipe extending into an injection chamber of the shaping apparatus towards an exit of the chamber and is passed out at the exit through a die having an opening with a smaller cross-sectional area than the bore of the pipe while hot compressed gas is injected into the chamber through an injection opening thereof with the result that the fibre bundle is heated and shaped at a hot-melt-adhesive temperature.

2. A process according to claim 1 wherein as the fibre bundle passes through the pipe it is indirectly heated by the gas through the wall of the pipe, as well as being heated directly by such gas passing through the inside of the pipe.

3. A process according to claim 1, wherein the fibre bundle is directly heated by the hot compressed gas as the bundle passes from the end of the pipe to the die.

4. A process according to claim 1, 2 or 3 wherin the fibre bundle is tow, filaments, sliver, or spun yarns.

5. A process according to any preceding claim, wherein the fibre bundle consists of 20 to 100% by weight of the hot-melt-adhesive composite fibres and 80 to 0% by weight of one or more of natural fibres, bast fibres, chemical fibres and synthetic fibres.

6. A process according to any preceding claim, wherein the difference between the melting points of the composite components constituting the hot-melt-adhesive composite fibres is in the range of 10°C to 100°C; the hot-melt-adhesive composite fibres have a side by side or sheath and core structure; and the circumferential proportion in the fibre cross-section, of the low melting component, is in the range of 50 to 100%.

7. A process according to claim 6 wherein the difference between the melting points of the composite components is in the range of 20°C to 60°C.

8. A process according to any preceding claim, wherein the combination of the composite components constituting the hot-melt-adhesive composite fibres is (polypropylene/polyethylene), (polypropylene/ethylene-vinyl acetate copolymer), (polypropylene/saponified product of ethylene-vinyl acetate copolymer), (polypropylene/a mixture of ethylene-vinyl acetate copolymer with polyethylene), polypropylene/a mixture of saponified product of ethylene-vinyl acetate copolymer with polyethylene), (polyester/polypropylene) or (nylon 6/nylon 66).

9. A process according to any preceding claim, wherein the pressure and temperature of the hot compressed gas are in the range of a line pressure of 1 to 5 Kg/cm²(G) and in the range of a temperature of 110°C to 220°C, respectively.

10. A process according to any preceding claim, wherein the ratio of the cross-sectional area of the bore of the introduction pipe to that of the opening of the die is in the range of 1.2:1 to 4:1.

11. A process according to any preceding claim, wherein the ratio of the distance from the end of the introduction pipe within the injection chamber to the die, to the total length of said injection chamber including the pipe inside the injection chamber and said die, measured in the direction of travel of the fibre bundle, is in the range of 0.1:1 to 0.3:1.

12. A felt-tipped pen, tipped cigarette or other manufactured product which incoporates a rod-shaped article produced using a process as claimed in any preceding claim.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1980. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.